features presented on the sheets of this Atlas make it all the more regrettable that the interval between the publication of the sheets is so long. It is about eighteen years since the first sheets were published, and twenty-six of the ninety sheets still remain to be issued. The whole of Europe has appeared excepting the general maps of the British Islands and Iberian Peninsula and the southeast sheet of Spain and Portugal in four sheets. Nine of the fourteen sheets of Asia, six of the twelve sheets of Africa, six of the twelve sheets of North America, and the whole of South America and Oceania have been issued. No. 3 is a hypsometric map of the world in hemispheres, six colors showing land altitudes and six tints of blue indicating sea depths, with smaller maps giving meteorological and climatological data, zones of vegetation, and ocean currents. No. 19 is the southwest sheet of the four-sheet map of Spain and Portugal, with inset maps of the Canaries and Azores.

PHYSIOGRAPHIC NOTES.

BY

RALPH S. TARR.

River Piracy in Southeastern Missouri.—Although it is probable that the last word on Crowley Ridge has still to be said, Marbut (University of Missouri Studies, Vol. 1, No. 3, 1902) has done much to clear up the problem which this interesting upland presents. Written upon by Call and by Branner, and studied later by Marbut, while a student at Harvard, the Crowley Ridge presents problems that have led Marbut to extend his investigations and survey over a period of four years, and it is with the results of this study that his present paper deals. He arrives at substantially the same general conclusions that Branner reached in 1889, bringing forward additional evidence in many cases, and contributing pertinent facts as well, concerning the processes of stream development and river capture.

The area discussed lies in Missouri, near the confluence of the Mississippi and Ohio, and consists of two main areas of lowland, separated by several upland ridges, of which the Crowley Ridge is the largest. The lowland between Crowley Ridge and the Ozark Upland is an abandoned valley of the Mississippi, which formerly joined the Ohio some distance below their present junction at Cairo. Marbut's studies show that the Mississippi cut this inner bottomland, while the much larger lowland area east of Crowley Ridge was made by the Ohio. The Mississippi was, later, twice diverted from its course, eventually entirely abandoning its lowland, being

diverted through the narrow gorge into which the river sharply turns just below Cape Girardeau.

That a stream so much larger than the Ohio as is the Mississippi should have been able to make a lowland belt very considerably smaller than that developed by the smaller stream would naturally invite an investigation of the causes and influences to which the streams have been subjected; and when the further facts are considered that the Mississippi has twice left its developed course, abandoning in the first case 200 miles and in the second 50 miles of its valley to flow through a narrow gorge which had to be wholly readapted to fit its new occupant, and that the latest turning aside is so recent that Paleozoic rocks in the stream course still form a dangerous rapid, the "Grand Chain" just below Cape Girardeau, it seems worth while to look into the causes which result in stream capture generally, and especially those which have operated here. The twice-repeated filching of the larger stream by the smaller has resulted from the combination of favourable conditions and suitable intervals of time for their operation.

Marbut shows that the development of the larger lowland by the Ohio is due to the fact that it was working in soft, unconsolidated rocks, the Tertiary clays and gravels and Pleistocene loams and loess, while the Mississippi was held up by the indurated Paleozoic limestones and sandstones of the Trenton. Moreover, the Mississippi has a steeper grade than the Ohio; it was not relieved of its heavy burden by the melting back of the ice-sheet from its headwaters until after the Ohio, and it was never relieved of the loads of sediment dumped in by the Missouri. Consequently the Ohio has been able to push back its divide into the drainage area of the Mississippi and rob it of some of its tributaries. The Mississippi, cutting against the low divides thus formed, has pierced the valley of its own captured tributaries at a low enough point to be diverted into the lower valley, and hence into the Ohio itself. Thus, in re-capturing its captured tributaries the Mississippi has

found it necessary to abandon two valleys in succession, after each was eroded down to grade and opened out to a width of several miles, in favor of the valleys of small creeks, which it had to work over and enlarge in order to make them suitable for its purpose.

The writer discusses the diversion of each of the several creeks, giving an excellent discussion of river capture. How capturing was done is summed up in the following quotation:

The valleys of two streams are separated by a narrow belt of upland. A small stream flows into one of them, heading on the upland between the two main streams. That one of the larger streams into which the small stream does not flow saps

the bluff on the side nearest the other large stream, gradually working toward the head of the small tributary. By continued sapping it finally cuts off the head of the tributary; then, continuing, cuts off more and more of it, reaching a lower and lower level of its valley, thus deepening the gap between its valley and that of the other large stream. It finally reaches a point where it can shorten its course by flowing into the other stream through the beheaded trunk valley of the tributary, abandoning the lower part of its own valley.

Other interesting physiographic points brought out by the paper concern themselves with questions incidental to the main problem, among which the beheading of the Crowley Ridge drainage may be noted. The work has been exhaustive; some of the applications are ingenious; they all seem rational.

THE ORIGIN OF HANGING VALLEYS.—Professor Davis's recent paper on the hanging valleys of the Alps and elsewhere, in which he explains them by glacial erosion, has called forth two papers opposing his explanation, one by Bonney (*Quarterly Journal Geological Society*, LVIII, 1902, 690–702), the other by Garwood (Same, 703–718). Bonney's paper opens with a criticism of Professor Davis's methods, stating essentially that he had hurried over the region and jumped at a conclusion. Those who are more familiar with Professor Davis's powers and methods are aware of the fact that he was prepared for his investigation by a long previous study of Swiss topographic sheets and by a long and diverse experience in the study of the physiography of many regions. Moreover, Professor Davis's training and powers are such that he is able to see where others do not.

That Bonney is not in sympathy with the development of physiography that has been made in the United States is shown by a number of passages in his paper. He, for example, states that he prefers the old term dip and strike valleys in the place of the newer consequent and subsequent, as if these terms were really synonymous.

The paper by Bonney is prefaced by some remarks concerning the earlier history of the Alps. He holds that the action of snow is conservative rather than destructive, that cirques and overdeepened valleys have been formed by running water, and that the erosive work of ice has been on a small scale, such as the formation of shallow basins and roches moutonnées. On the other hand, he points out the fact, to which every one will agree, that water is known to have the power of excavating, and, moreover, that its work can be seen. Therein appears to lie the chief difficulty that stands in Bonney's way—namely, that he cannot see ice erosion in

progress. He seems to hold that because small glaciers near their margins are not at the present time doing great tasks of erosion therefore ice has never done much work of that sort.

His view of the origin of the hanging valleys is as follows: The Alpine valleys are almost wholly preglacial, the gorge cutting dating from late Pliocene times. The hanging valleys are due to the fact that glaciers remained in the side valleys, thus checking denudation, while the downcutting of the main valleys was increased by the torrents of water coming from the melting ice. He cites many instances in support of this view, and concludes that, while Professor Davis's hypothesis derives little support from the facts, his own hypothesis is far better supported.

Garwood's paper is, in general, similar to Bonney's, though he seems to have more respect for Professor Davis's work. In fact, he says that Davis states the facts regarding the Ticino valley correctly. His attention was first attracted to hanging valleys in the Himalayas, and he has studied the Ticino and numerous other valleys. According to his interpretation, the region of the Ticino valley was uplifted, and the hanging valleys produced, probably during interglacial times, being occupied, as Bonney has suggested, by glaciers, which preserved them. He concludes that ice is a weak agent of erosion, from observations he made at the ends of the glacier in Switzerland and in the Arctic. It seems exceedingly strange to find two men applying criteria from the weak ends of small glaciers in the interpretation of work done by deep ice moving vigorously over a region. It is much like examining a small stream flowing through a meadow and from it concluding that a river could not cut out a Colorado cañon. To interpret correctly the work performed by great ice masses, one must divorce himself from prejudice at the outset and be ready to accept the result of observed fact; no matter what his preconceptions may have been concerning the powers of the agent. Perhaps there is no one who would hold that ice is not protective when compared to the work which is done by rivers; but to admit this is far different from holding that, while ice protects a valley which it occupies, it is nearly inactive.

After reading these two papers the physiographer cannot help wondering whether either of the authors is in sympathy with the basal principles of the new physiography. For example, Mr. Garwood speaks of the hanging valleys of the Italian lakes, mentioning especially the one at Menaggio, on Lake Como. These he ascribes to the holding up of lake waters while the hanging valleys developed

at that temporary base level. Lake-lowering, then, allowed the hanging valleys to be downcut. This process is truly a possibility; but one is warranted in asking several questions. Has time enough elapsed since the lakes were formed to permit the formation of the broad valley that hangs above Lake Como at Menaggio? It has a mature form. The required time for so mature a valley must have been great enough for the lake to be nearly or quite filled. The gorge which now takes the water through this hanging valley into Lake Como is young enough to be postglacial in age. Where, then, are the lake beaches and deltas that were formed at this higher level? And what accounts for the depth of the Lake Como valley below the level of the hanging valley? These are physiographic difficulties which seem utterly opposed to Garwood's explanation.

The hypothesis that hanging valleys were caused by the protection of ice tongues brings forward one or two difficulties which seem far more serious than that of explaining how ice can erode. The over-deepened valleys to which the hanging valleys are tributary are quite wide and U-shaped; that is, their form is such that, if formed by water, no small amount of time has been required. During this time the hanging valleys must have been filled with ice tongues almost down to the edge of the main valley. This requires a period of stability in ice position quite unlikely to occur. If the ice tongues did not nearly fill the hanging valleys during the deepening of the main valleys either one of two things must have happened: (1) Either the outrush of water must have cut gorges, or (2) the water must have been so overburdened with sediment as to have built wash deposits. The absence of either of these evidences of ice occupancy is certainly suggestive. It seems like appealing to a most unnatural cause to explain what is far more simply explicable by ice erosion.

Finally, and as a very strong argument in favor of ice erosion, is the fact that well-defined cirques and over-deepened and hanging valleys are among the common features of glaciated regions, while they have so far not been reported in unglaciated regions. Moreover, there are hanging valleys in many places where the theory of protective ice tongues could not even be advanced; for example, in the hanging valleys tributary to the Lake Cayuga valley, in central New York. In unglaciated regions side valleys are in harmony with the main valleys. The Colorado River, for example, is rapidly cutting along its bed. Its small tributaries are weak in the extreme, being free from water during a large part of the year; yet at their

mouths they are able to keep up with the vigorous work of the main stream.

In these comments on the two papers I do not bring forward again the statement regarding overlapping spurs which Professor Davis brings out in his paper. From what Bonney and Garwood say it seems evident that neither of them appreciates the full significance of this evidence in favor of glacial erosion.

THE HUICHOL INDIANS OF MEXICO.

BY

CARL LUMHOLTZ.

There are living to-day in Mexico about fifty different tribes of Indians, each speaking its own language. Besides, over a hundred and fifty dialects are spoken, so that in all there are in use in that Republic as many as two hundred idioms, none of which is understood by those who speak the others. This diversity of language is partly due to the taciturnity and exclusiveness of the Indians.

In this conglomeration of tribes four were found, at the time of the Conquest, to be far superior to the others, and in possession of a remarkably high culture. These were the Aztecs, the Mayas, the Mixtecs, and the Zapotecs. When the Spaniards invaded Mexico they found these tribes practicing the art of picture writing in their peculiar books, as well as on their stone monuments. Their wonderful architecture and sculptures, the high development of their governmental and religious systems, the barbaric splendour and wealth in which these nations lived, not only baffled the invaders, but the better they become known to the civilized world of the present age the more they excite wonder and admiration. In many sciences, especially in botany and astronomy, these so-called barbarians were in advance even of the Europe of that time. Yet at the very doors of these highly-advanced races there dwelt tribes, such as the Huichol Indians, whose limited intellectual power forced them to remain mentally and socially in an absolutely primitive condition. Strange as this may seem, the fact in itself is by no means unique. Similar instances of wide diversities of culture